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H₂O across the reactor and ~0.14 inches H₂O across the vaporizer. In the current rapid start testing, at 30 seconds, when full reformat is being produced, the combustion side air flow rate was maintained at 1000 slpm while hydrogen was decreased over time to maintain the combustion inlet <1000 C. The pressure drop across the reactor and vaporizer panels was 14 and 8 inches respectively under the high flow high temperature condition.

Several changes are planned to improve the current system performance. First, the reactor will be fabricated in an Inconel alloy to allow high temperature operation. This will reduce the thermal mass of the reformer to <1/3 of the current value. An additional 40% of the reactor mass is expected to be eliminated through design changes. The total air flow being used will be reduced by using higher combustion temperatures at lower air flow rates. The greater temperature driving force along with the reduced velocity on the combustion gas side will be utilized to reduce the air flow volume and pressure requirement during startup (as well as at steady-state). Current targets are that the startup air flow for a 50 kWe system will be in the 450-600 scfm flow range with a maximum pressure drop in the 5" to 10" H₂O range. The mechanical power input for a 75% efficient blower providing 600 scfm at 10" H₂O is 931 watts which places the air movement within reach of a conventional lead-acid automotive battery.

Closure

While the invention has been illustrated and described in detail in the drawings and foregoing description, the same is to be considered as illustrative and not restrictive in character. Only certain embodiments have been shown and described, and all changes, equivalents, and modifications that come within the spirit of the invention described herein are desired to be protected. Any experiments, experimental examples, or experimental results provided herein are intended to be illustrative of the present invention and should not be considered limiting or restrictive with regard to the invention scope. Further, any theory, mechanism of operation, proof, or finding stated herein is meant to further enhance understanding of the present invention and is not intended to limit the present invention in any way to such theory, mechanism of operation, proof, or finding.

Thus, the specifics of this description and the attached drawings should not be interpreted to limit the scope of this invention to the specifics thereof. Rather, the scope of this invention should be evaluated with reference to the claims appended hereto. In reading the claims it is intended that when words such as "a", "an", "at least one", and "at least a portion" are used there is no intention to limit the claims to only one item unless specifically stated to the contrary in the claims. Further, when the language "at least a portion" and/or "a portion" is used, the claims may include a portion and/or the entire items unless specifically stated to the contrary. Likewise, where the term "input" or "output" is used in connection with an electric device or fluid processing unit, it should be understood to comprehend singular or plural and one or more signal channels or fluid lines as appropriate in the context. Finally, all publications, patents, and patent applications cited in this specification are herein incorporated by reference to the extent not inconsistent with the present disclosure as if each were specifically and individually indicated to be incorporated by reference and set forth in its entirety herein.

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What is claimed is:

1. A method comprising:

providing a fuel cell system including a fuel reforming reactor and at least one blower for selectively conveying combustion gas through a heating side of the reforming reactor at different mass flow rates;

starting-up the reforming reactor by heating a reforming side of the reactor with a combustion gas flowing through the heating side of the reactor, wherein the combustion gas flows through the heating side of the reactor from a first face of the reactor to a second face of the reactor, and wherein the first and second faces each have a length and width substantially greater than the distance between the faces; and then

operating the reactor to produce a reformat stream by driving an endothermic reforming reaction on the reforming side with heat from a combustion gas flowing through the heating side;

wherein a mass flow rate of combustion gas through the heating side during the starting-up is at least about five times a mass flow rate of combustion gas through the heating side during the operating.

2. The method of claim 1 wherein the pressure drop across the heating side of the reforming reactor during the starting up is less than about 10 inches of water.

3. The method of claim 2 wherein the system includes a vaporizer having a heating side downstream from the heating side of the reforming reactor, and the combined pressure drop across the heating side of the vaporizer and the heating side of the reforming reactor during the starting-up is less than about 10 inches of water.

4. The method of claim 2 wherein a Reynolds number of the combustion gas flowing through the heating side during the starting up is less than about 2000.

5. The method of claim 1 wherein the system includes a vaporizer having a heating side downstream from the heating side of the reforming reactor, the vaporizer including a first face and a second face each having a length and width substantially greater than the distance between the faces, the method further comprising flowing the combustion gas through the heating side of the vaporizer from the first face of the vaporizer to the second face of the vaporizer.

6. The method of claim 5 wherein there is no intervening heat exchanger between the heating sides of the reforming reactor and the vaporizer.

7. The method of claim 1 wherein there are at least two blowers.

8. The method of claim 1 wherein the starting up includes raising an internal temperature of the reforming side from below about 50° C. to above about 400° C. while the at least one blower consumes an amount of power less than about 4% of the steady state electrical output of the fuel cell system.

9. The method of claim 1 wherein the S:C ratio during the starting-up is at least about 4 times greater than during the operating.

10. The method of claim 9 wherein the S:C ratio during the starting-up is at least 8 times greater than during the operating.

11. The method of claim 1, wherein the temperature of the combustion gas at the first face of the reactor is at least 200° C. greater than the temperature of the first face of the reactor during the operating.

12. The method of claim 1 further comprising conducting heat through the reactor away from an inlet to the heating side of the reactor to prevent the metal temperature at the inlet from exceeding a maximum operating temperature when the combustion gas at the inlet is at least about 200° C. above the maximum operating temperature.

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